Iowa Department of Natural Resources
Environmental Protection Commission

ITEM **21** **INFORMATION**

TOPIC **Manure Application on ground that will be planted to soybeans.**

The Commission has discussed the topic of fertility, nutrient application rates and timing, and the role of the EPC in establishing standards for fertility practices. These discussions occurred in November, 2005, and were also discussed during the February, 2006 meeting. At the February meeting, the EPC requested the staff to report back with alternatives that would address the issue of manure being applied to ground that will be planted to soybeans.

Dr. Jim Baker presented information at the February meeting that summarized the results of field trials comparing fall versus spring application of manure and nitrogen. In addition, a summary of available research on the subject prepared by Jeremy Klatt, a DNR field specialist, and Dana Dinnes, an employee of the Soil Tilth Lab, is attached. This paper gives further information on the issue.

Economically, there are very few farmers who would pay for the application of nitrogen to land that is being planted to soybeans because of the low or negative return on investment that such a practice would generate. Data suggests that nitrogen applied to soybeans in either manure or commercial forms can cause higher levels of nitrates in tile line discharges. While the EPC is charged with environmental protection, this is one of those rare instances when environmental protection and common sense economics combine to support the proposition that manure should not be applied to a crop that has the ability to fix its' own nitrogen from natural sources.

Even given this fact, approximately 50% of the manure management plans (mmps) submitted to the department calls for this practice. The reality of this number means that in order to implement a rule that would prohibit this practice, a large number of existing mmps would have to be modified. New land would have to be acquired by producers in order to meet this new requirement. At the same time, producers are in the process of converting their existing mmps to a P-index plan on a four year time frame that is included in our current rules. It is expected the EPA will propose a new CAFO rule in early June that will also impact timing and requirements for mmps. Provisions also need to include the very real possibility of weather conditions affecting cropping patterns. (For example, wet weather delaying the planting of a corn crop and a resulting switch to soybean production.) And, while it is not often a factor considered when adopting or considering a rule, there are large implications in terms of DNR staff time, database conversion issues, notification to existing mmps holders and general planning for implementation that our management staff have to consider.

In view of all these factors, it is the staff recommendation that the EPC form a working group charged with bringing a recommendation to the Commission that calls for the prohibition of the application of manure on ground that will be planted to soybeans. The working group should consider a time frame for implementation, the impact of new rules from EPA, the current conversion of mmps to a p-based standard, and the ability of the staff to make necessary changes and modifications to existing programs.

Wayne Gieselman, Administrator
Environmental Services Division
Iowa Department of Natural Resources

April 28, 2006

Manure Application to Soybean

Agronomic and environmental considerations

Jeremy Klatt – Nutrient Specialist, Iowa DNR
Dana Dinnes – Ag Environmental Scientist, Iowa DNR/USDA-NSTL

Introduction

Producers who are required to complete a manure management plan (MMP) in Iowa currently have the option of applying manure to land where soybean will be the subsequent crop. From a manure allocation standpoint this is beneficial to the producer because it allows annual application of manure to a corn-soybean rotation, which reduces the land base needed for manure application. The maximum allowable application rate to soybean in a MMP is determined by the amount of nitrogen (N) that is expected to be removed from the field with harvest. According to Iowa State University Extension, the removal rate of soybean is 3.8 lbs N/bu (Killorn and Lorimor, 1999). Therefore a soybean crop with a yield goal of 45 bu/acre can receive manure at a rate that applies 171 lbs N/acre. Manure application to soybean is currently an option in an MMP because research indicates that soybean will use available soil N in lieu of producing it through N fixation (Sawyer, 2002). Moreover, when current MMP requirements were developed, the emphasis was on N management; managing the phosphorus (P) in the manure was addressed as a recommended practice. The following sections provide a summary of current agronomic and environmental research concerning manure application in soybean production and also considers the effect that P index implementation may have on this practice.

Agronomics

For agronomic purposes, animal manures are not typically applied for soybean production because there is little to no economic benefit to the added manure-N compared to that for corn production (Sawyer, 2002). Research experiments in Minnesota and Iowa have shown that soybean grain yields following manure application ranged from only slightly increased to slightly decreased compared to non-manured control treatments (Schmidt et al., 2000; Schmidt, et al., 2001; Sawyer, 2002). Decreased yields were attributed to incidences of increased brown stem rot, white mold and lodging (Schmidt, et al., 2001; Sawyer, 2002). Slightly increased yields were attributed to greater available N early in the soybean growth period when symbiotic fixed N is minimal, and during the high N demand period of seed fill (Schmidt et al., 2001). However, increased yields cannot solely be attributed to increased available soil-N from the manure. Other nutrients supplied by the manure, such as P, potassium, and micronutrients can positively influence soybean yield. Additionally, manure has been shown to increase soil organic matter content, which improves the soil's water holding capacity and structure that is beneficial to plant growth and production. The environmental impact of manure application to soybean is another important consideration.

Effect on Nitrogen in Subsurface Drainage Water

Minnesota experiments (Schmidt et al., 2000) that measured residual soil-nitrate after soybean harvest suggested that there is minimal potential negative impact as long as the rate of available manure-N is below or at the amount of N removed in soybean biomass (plant and grain). Manure-N applied above soybean N requirements did result in elevated residual soil-nitrate and thus an increased risk for nitrate leaching to water resources (Schmidt et al., 2000). In these Minnesota experiments it is important to note that manure was primarily applied in the spring, just prior to soybean planting, not in the previous fall following corn harvest. There is research in Iowa that suggests increased nitrate losses in cropping systems with manured soybean. Kanwar et al. (2002) show preliminary experimental results from Iowa that indicate there can be substantial increases in nitrate leaching to water resources from manured soybean fields compared to manure applied to corn and non-manured soybean. There are several possible reasons for the increased nitrate leaching from manured soybean, all of which relate to soybean growth characteristics. The first reason for potentially increased nitrate losses is that soybean has a shorter period of active growth and nutrient uptake than that of corn. Soybean does not develop a root system extensive enough to exploit available soil nutrients across a field's entire area until late-June to early-July, and soybean senescence typically occurs by mid- to late-September. The root system of corn develops sooner than that of soybean and remains active in uptake of soil nutrients later into the fall than soybean. So, the opportunity for manure-N to be assimilated into the crop is greater for corn than soybean, which relates to a greater risk of nitrate leaching from manure-N applied to soybean. Secondly, a soybean root system does not extend as deep into the soil profile as does a corn root system. So, there is a greater opportunity for nitrate derived from manure-N to leach below a soybean crop root system than from a corn crop root system.

Effect on soil phosphorus levels

The N and P concentrations of manure are such that N-based manure application to both corn and soybean in rotation typically applies more P than is removed with the crops and results in an accumulation of P in the soil. The extent of the P accumulation depends on the N to P ratio of the manure. For instance, under a typical management scenario in Iowa[1] and following methods used to calculate manure application rates in a MMP, 131 and 147 lbs P_2O_5/acre will be applied with an N-based rate to the corn and soybean crops, respectively. Assuming a corn yield of 165 bu/acre and soybean yield of 45 bu/acre, about 100 lbs P_2O_5/acre will be removed with the harvest of the two crops. Therefore, an excess of 180 lbs P_2O_5/acre is applied to the soil every two years. In systems like this, with P applications exceeding crop need, soil P levels can increase over time to well above optimum levels for crop production. For comparison, if manure wasn't applied to soybean in this scenario, an excess of 31 lbs P_2O_5/acre would be applied to the soil over the two year period; this would have a relatively small effect on soil P levels. Iowa research has showed soil P concentrations four times greater than optimum levels in a system receiving annual manure applications in a corn/soybean rotation (Mallarino et al., 2002a). Reducing manure applications to rates that are closer

1 Corn(165 bu/acre)/Soybean(45 bu/acre) rotation; Manure N= 50 lbs/1000gal, P_2O_5=42 lbs/1000gal; injected

to the P needs of the crop rotation can help maintain soil P levels (Eghball and Power, 1999). If soils are deficient in P, applying manure to soybean is a way to build up soil P to optimum concentrations. However, if soil P levels are already excessive, applying N-based manure annually to corn and soybean in rotation will further increase soil P levels, which over-time could create an environmental concern. It should be recognized that soil P above optimum levels for crop production doesn't necessarily indicate a high risk for P loss. The Iowa P-index was developed to provide a comprehensive estimate of P loss that considers not only soil P, but other factors that affect P loss from fields such as soil properties and land management (Mallarino et al., 2002b).

Effect of the P-index rule adoption on manure application to soybean

With adoption of the P-index, MMPs will determine application rates on a field-by-field basis. Manure applications will be based on N or P depending on the risk of P loss from a particular field as indicated by the P-index. If manure application is determined by N, then application rates will follow current guidelines, which permit manure application to soybean. If manure application rates are determined by P, then manure will be applied at rates that replenish the amount of P removed with harvest. Under this type of management, it will be very difficult to apply manure annually in a corn/soybean rotation, even when considering P reductions in manure associated with recent technologies such as phytase. In this case it's economical to apply the manure to the corn and not the soybeans, which would reduce the occurrence of manure application to soybean. There will be situations, particularly on land with low erosion rates, that manure can be applied to soybean ground as part of an N-based management system. However, in an N-based system, producers need to consider the effect their management system will have on soil P levels because increased soil P will increase the field's P-index rating. Continued over-application of P in an N-based system will eventually raise the P-index rating to such levels that P-based management is required. By eliminating manure application to soybean in an N-based management system, P applied with manure will be closer to P removal rates. This will keep soil P levels lower and maintain the P-index at levels that consider N-based manure management appropriate. Therefore, implementation of the P-index will likely reduce the occurrence of manure applications to soybean, however, this management practice will still occur in some situations.

References

Eghball, B. and J.F. Power. 1999. Phosphorus- and nitrogen-based manure and compost applications: corn production and soil phosphorus. Soil Sci. Soc. Am. J. 63:895-901.

Kanwar, R., C. Pederson, J. Baker, A. Mallarino, J. Sawyer and K. Pecinovsky. 2002 Fertilizer and swine manure management systems: impacts on crop production and nitrate-nitrogen leaching with subsurface drainage. p3. Available on-line at http://www.ag.iastate.edu/farms/02reports/ne/ManureMgmtCrop.pdf (Accessed and verified 8/25/03).

Killorn, R. and J. Lorimor. 1999. Managing manure nutrients for crop production. Iowa State University Extension. PM-1811. Iowa State University Extension. Ames, IA

Mallarino, A., J. Sawyer, J. Klatt, R.Kanwar, C. Pederson, J.Baker, K. Pecinovsky. 2002a. Fertilizer and swine manure management systems: Impacts on agronomic and environmental soil phosphorus tests and on phosphorus loss with subsurface drainage. p2. Available at http://www.ag.iastate.edu/farms/02reports/ne/ManureMgmtAgronomic.pdf (Accessed and verified on 8/25/03).

Mallarino, A.P., B.M. Stewart, J.L. Baker, J.D. Downing, and J.E. Sawyer. 2002b. Phosphorus indexing for cropland: Overview of basic concepts of the Iowa phosphorus index. J. Soil Water Conserv. 57:440-447.

Sawyer, J.E. 2002. Nitrogen fertilizer or swine manure application to soybean. p12. Available at http://extension.agron.iastate.edu/advantage/2002/materials/02w-sawyer-nm.pdf (Accessed and verifed 8/25/03). Iowa State University Extension. Ames, IA.

Schmidt, J.P., J.A. Lamb, M.A. Schmitt, G.W. Randall, J.H. Orf, and H.T. Gollany. 2001. Soybean varietal response to liquid swine manure application. Agron. J. 93:358-363.

Schmidt, J.P., M.A. Schmitt, G.W. Randall, J.A. Lamb, J.H. Orf, and H.T. Gollany. 2000. Swine manure application to nodulating and nonnodulating soybean. Agron. J. 92:987-992.